United States
Department of
Agriculture

Forest Service

**Rocky Mountain
Forest and Range
Experiment Station**

Fort Collins,
Colorado 80526

General Technical
Report RM-192

Estimating the Recreational, Visual, Habitat, and Quality of Life Benefits of Tongass National Forest

Alan Randall, John P. Hoehn, and Cindy Sorg Swanson

Abstract

A conceptual framework for evaluating the nonmarket benefits of the Tongass National Forest is presented. Standard theory of benefit estimation is expanded to incorporate the array of environmental services in a complex and holistic environment found in the Tongass. As suggested in this report, the general framework outlined can be applied in many national forests. Short- and long-term recreation valuation studies are outlined along with the likelihood of obtaining reliable results from each study.

Acknowledgment

Funding and support for this research was provided by the Tongass National Forest recreation staff and the Rocky Mountain Forest and Range Experiment Station, Valuation of Wildland Resource Benefits project. Special thanks to Jim Cochrane, Phil Janik, George Peterson, Chuck McConnell, and Ginny Worthington for helpful suggestions and comments.

USDA Forest Service
General Technical Report RM-192

June 1990

Estimating the Recreational, Visual, Habitat, and Quality of Life Benefits of Tongass National Forest

Alan Randall, Professor
Ohio State University

John P. Hoehn, Assistant Professor
Michigan State University

and

Cindy Sorg Swanson, Economist
Rocky Mountain Forest and Range Experiment Station[1]

[1] *Headquarters is in Fort Collins, in cooperation with Colorado State University. Currently, Cindy Sorg Swanson is wildlife Economist, USDA Forest Service Northern Region, Missoula, MT.*

Estimating the Recreational, Visual, Habitat, and Quality of Life Benefits of Tongass National Forest

Alan Randall, John P. Hoehn, and Cindy Sorg Swanson

INTRODUCTION

The Tongass National Forest includes most of southeast Alaska, a region that is relatively isolated from major population centers by distance and lack of highway access. The region provides a distinctive living environment for its 65,000 residents, and a variety of unusual vistas and recreation opportunities for visitors. The residential and visitation experiences in southeast Alaska are inextricably linked with the Tongass, so that management decisions on the forest influence many (if not most) benefits of living and visiting there. In turn, estimation of the benefits of baseline and alternative management strategies is essential to choosing desirable strategies.

The southeast Alaskan environment is unusual in many respects: geography, topography, the land-sea interface, climate, ecosystems, scenery, and human lifestyles. These attributes tend to invalidate some of the standard methods of estimating the benefits of nonmarketed environmental services. The problem is not with the standard theory of benefit estimation (welfare change measurement theory) but with some of the simplifications that have been imposed in the course of developing some commonly applied empirical methods.

This report presents a conceptual framework for evaluating the nonmarket benefits of the Tongass National Forest. The intent is to apply the standard theory of benefit estimation, but in a way that more thoroughly estimates benefits of environmental services in a complex and holistic environment. The next section discusses the challenge of this complexity, and subsequent sections present our response. While the Tongass is perhaps an extreme case, many of the benefit estimation contexts encountered in national forests have some of the same characteristics. Our conceptual framework and the research procedures developed and refined in the course of the research recommended should subsequently see widespread application.

CONCEPTUAL CHALLENGES

The research program in empirical valuation of goods and services that are not marketed directly is now about 30 years old. The first problem to be attacked was valuing access to recreation sites. More research has accumulated on recreation benefits than perhaps any other nonmarket values, and the recreation problem is most frequently specified in terms of a single-purpose, single-destination day-trip to a site that affords some particular recreation experience (such as boating) of "typical" quality. From the accumulation of results from this kind of research, there have emerged consensus estimates of the value of a visitor-day of various activities. These visitor-day values are often multiplied by the number of visitor-days recorded (or projected) at particular sites to estimate annual aggregate recreation benefits. This procedure conceptualizes the recreational trip as single-purpose and single-destination, and the recreation experience as homogeneous, separable, and linear.

Of course, the research program in nonmarket valuation has expanded well beyond this simple case: beyond recreation to many other goods, services, and amenities; beyond the limited assumptions of the visitor-day values approach to use values; and beyond use values to total value, including option and existence values. Similarly, the tool-kit of techniques has expanded to include several variants of the travel cost method, hedonic price analysis, and contingent valuation. This expansion of the research program has brought some successes, but also some new problems and a renewed appreciation of some old problems.

Valuing the nonmarket benefits generated by the Tongass National Forest is a task that embodies many, if not all, of the challenges that confront research in nonmarket valuation. The Tongass situation is as different as can be imagined from the single-purpose, single-destination day-trip to a site that provides an experience interchangeable with those available at many similar sites. Some of these differences are:

a. The vastness of the Tongass National Forest and its dominance of its environs. The Tongass National Forest includes a land area of almost 27,000 square miles, the vast majority of all land in southeast Alaska. The forest is about 500 miles long and 100 miles wide. From anywhere in southeast Alaska—towns, roads, back-country, the inner passage for shipping, or the quiet waters for canoeing and kayaking—the viewshed includes (and is typically dominated by) the Tongass National Forest. Land-use management decisions on the Tongass influence the scenery, visibility, habitat, ecological diversity, comfort and convenience of visitors and residents alike, and the economic opportunities for residents in a local economy driven by recreation, tourism and the natural resource industries. Management decisions on the Tongass have nonmarginal influences.

b. The long distance and limited access from major population centers. There are no highway links with the

rest of the United States, so people must enter and leave southeast Alaska by air or sea. This imposes additional costs on local residents, and it makes recreation and tourism expensive for visitors. Visits are major events in the lives of the visitors: expensive, multi-day, multi-destination, multi-purpose events that bear little resemblance to the kinds of day-trips to which user-day values were intended to be applied.

c. The importance of interrelationships among recreational and environmental services. The factors discussed above all combine to create a holistic living environment and a holistic visitation experience, in which substitution and complementarity relationships among environmental services are very important. The assumptions of separability, linearity, and additivity would, if applied to the Tongass situation, divert attention from the essential characteristics of the problem.

d. The importance of quality of life for the 65,000 residents of southeast Alaska. These residents live mostly in small cities and towns surrounded by the Tongass. Whereas environmental values on some national forests are enjoyed mostly by visitors, residential quality of life is an important component of the benefits generated by the Tongass National Forest.

e. The relative importance of nonuser values. For many reasons, the Tongass is valued by many people who are neither residents nor visitors, but derive value from preserving an option for future on-site use, from off-site uses such as viewing photographs or films, or from the simple knowledge that the Tongass environment is assured a high level of continuing stability. These non-user values are influenced by management strategies on the Tongass. Off-site use and existence values are receiving increased attention in many places, but are expected to be especially important in the Tongass.

The special circumstances of the Tongass National Forest create major challenges for nonmarket benefit estimation. The goal of this research is to develop a conceptual framework that is grounded on recognized economic principles, but extends the valuation framework to deal more effectively with the holistic nature of the Tongass situation.

A VALID EVALUATION DESIGN FOR A COMPLEX ARRAY OF ENVIRONMENTAL SERVICES

The Tongass National Forest provides an extensive and varied array of environmental services enjoyed by regional residents, visitors, and people who value the Tongass environment for its existence and for the options it provides for future use.

Randall (in Peterson and Randall 1984, p. 54–57) outlines a general theoretical framework for benefit cost analysis of a proposal to modify the environment and, hence, the level of services it provides. Benefit cost analysis proceeds through several steps. The production relationships are specified so that the level of services under baseline and proposed conditions can be identified. Individual human valuations for environmental services

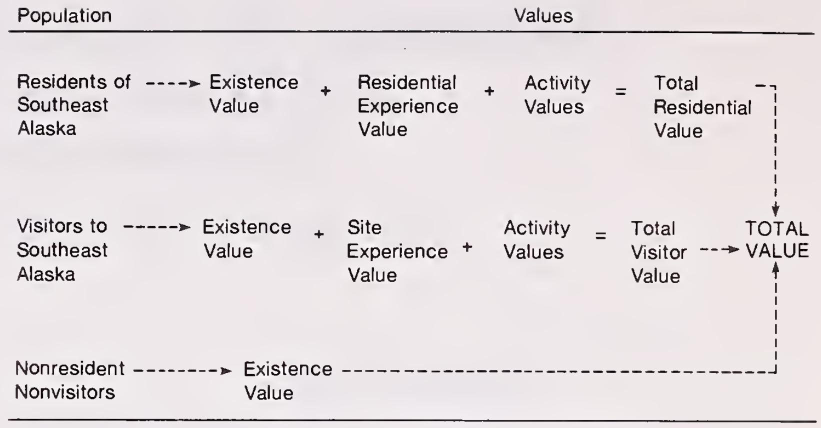

Figure 1.—The valid evaluation design.

are defined and estimated. Then, aggregate valuations are calculated by summing individual valuations across the affected human populations. The present value of baseline conditions is then calculated by aggregating across time periods with appropriate discounting of values accruing in the future. The present value of the proposed conditions is calculated similarly, and the net present value of the proposal is determined by subtracting the value of baseline conditions and the costs of implementing the proposal from the value of proposed conditions, all in present value terms. A positive net present value indicates that the proposal passes the benefit cost filter.

Evaluation of management alternatives for the Tongass, in benefit cost analysis or welfare change measurement terms, should follow this standard framework. Our purpose in developing an evaluation design for the Tongass situation is not to replace the standard benefit cost framework with some other construct. Rather, it is to elaborate one particular step—the correct specification and estimation of individual valuations for environmental services—in the context of a complex and holistic environment. Once a valid evaluation has been designed to estimate individual values for environmental services, the remaining steps in benefit cost analysis should proceed as outlined above.

We focus on the nonmarketed services provided by the Tongass environment, and assume they can be represented by a K-element vector $\mathbf{s} = (s_1,\ldots,s_K)$. Each of the K elements in **s** represents one element in the list of resource services provided by the Tongass. Each s_k is given a numerical value to represent a quantitative or qualitative attribute.

Nonresidents of southeastern Alaska may use these unpriced services, **s**, in two ways. First, Tongass services may be used on-site. On-site services may be enjoyed in specific activities or as the background setting for a stay in or travel through the Tongass region. Second, people may value Tongass services for off-site use or simply for the knowledge that they exist. These off-site use and existence values may be significant where Tongass services are unique or otherwise scarce (Randall and Stoll 1983).

The impact of **s** on a nonresident's economic well-being is represented by a utility function, u,

$$u = u(\mathbf{s}, b_T, \mathbf{x}, \mathbf{q}) \quad [1]$$

where b_T represents a trip to Tongass by a nonresident, and the vectors **x** and **q** represent, respectively, market goods and environmental services that a nonresident consumes in non-Tongass locales. The value that an individual places on the existence of Tongass services does not depend on a trip to the Tongass. For this reason, **s** enters the individual's utility function directly and apart from the impact of b_T.

VISITATION BENEFITS

The amount of well-being or satisfaction that an individual gets out of a visit, b_T, to the Tongass depends on (1) the market services, $\mathbf{x}_T$, used in travel to and staying in the Tongass; (2) the list of activities, $\mathbf{a} = (a_1, \ldots, a_I)$, enjoyed by a visitor at the Tongass; and (3) the unpriced services **s** that provide the background experience of being in or traveling through the Tongass. To put it another way, people "produce" nonhomogeneous trips by combining market goods, activities, and Tongass environmental services. Production of a visit is presented as a function:

$$b_T = b_T(\mathbf{x}_T, \mathbf{a}, \mathbf{s}) \quad [2]$$

Finally, the amount of satisfaction an individual obtains from an explicit activity in the Tongass depends on the market goods, $\mathbf{x}_i$, such as camping equipment or guide services an individual uses in a specific activity a_i; and the local services, **s**, that impact directly on the activity. An activity a_i is produced by the following process:

$$a_i = a_i(\mathbf{x}_i, \mathbf{s}) \quad [3]$$

For simplicity, from this point we consider only two on-site activities. Therefore, $i \in (1,2)$ and $\mathbf{a} = [a_1(\mathbf{x}_1, \mathbf{s}), a_2(\mathbf{x}_2, \mathbf{s})]$.

The Visitation Choice and Demand for Tongass Services

A decision to visit the Tongass is complex. Various modes of travel are possible, numerous sites may be visited, and many different activities may be enjoyed. We describe the structure of this complex decision by a three-stage household production model.

At the first stage of the decision, an individual considers the range of activities that are possible. An individual attempts to ascertain two elements of these activities: satisfaction that might be obtained and cost. The cost of an activity is represented by a cost index, c_i,

$$c_i(\mathbf{p}_i, \mathbf{s}) a_i = \min \mathbf{p}_i \mathbf{x}_i \quad \text{s.t.} \quad a_i \le a_i(\mathbf{x}_i, \mathbf{s}) \quad [4]$$

where $\mathbf{p}_i$ is the price of market goods used in the ith activity, and $a_i(\mathbf{x}_i, \mathbf{s})$ is constant returns to scale in $\mathbf{x}_i$. Therefore, the cost of a given level of activity, a_i, is $c_i a_i$.

At the second stage of the decision, an individual considers various bundles of activities, places to visit, and modes of travel. Each particular bundle defines a trip experience b_T as described by equation [2]. The cost of a given trip experience, b_T, is,

$$c_T(\mathbf{p}_T, c_1, c_2, \mathbf{s}, b_T) = \min \mathbf{p}_T \mathbf{x}_T + c_1 a_1 + c_2 a_2 \quad \text{s.t.} \quad b_T \le b_T(\mathbf{x}_T, \mathbf{a}, \mathbf{s}) \quad [5]$$

where $\mathbf{p}_T$ is the price of market services used in getting to and traveling within the Tongass National Forest.

At the final stage of the decision process, an individual considers the benefits of a trip to the Tongass relative to the benefits of other possible expenditures. It is at this stage that an individual decides whether to visit the Tongass and, if so, the type of trip experience to plan. The decision is made by identifying the trip bundle that maximizes well-being. This maximum level of well-being is,

$$v(\mathbf{s}, \mathbf{p}_T, c_1, c_2, \mathbf{q}, m) = \max u(\mathbf{s}, b_T, \mathbf{x}, \mathbf{q}) \quad \text{s.t.} \quad m \ge c_T(\mathbf{p}_T, c_1, c_2, \mathbf{s}, b_T) + px \quad [6]$$

where m is the individual's level of income and **p** is left implicit in $v(\bullet)$. The Kuhn-Tucker conditions,

$$\partial u/\partial b_T \le \lambda \partial c_T/\partial b_T, \; b_T \ge 0, \text{ and}$$
$$(\partial u/\partial b_T - \lambda \partial c_T/\partial b_T)\, b_T = 0 \quad [7]$$

describe whether or not the individual travels to the Tongass. If the marginal benefit of travel to the Tongass is less than the marginal cost of travel for all positive levels of b_T, the individual sets b_T equal to zero and does not travel. If the marginal benefit equals marginal cost for some b_T, the individual purchases the corresponding bundles of travel services. Notably, we should be able to find a set of prices high enough so that no individual takes a trip to the Tongass. Denoting these prices $\mathbf{p}_T^*$, c_1^*, and c_2^*, the individual's level of initial well-being, u^0, may be restored in the absence of travel to the Tongass by a compensating increase in income from m to m^*.

$$u^0 = v(\mathbf{s}, \mathbf{p}_T^*, c_1^*, c_2^*, \mathbf{q}, m^*) \quad [8]$$

Equation [8] summarizes the optimizing choices that an individual would make across market goods, activities, and unpriced services. These optimizing choices can be used to define two additional analytical tools. First, market goods demands are used to describe a valuation framework for the travel cost technique. Using equation [8] and Roy's identity (Varian 1984, p.126), the system of market goods demands is,

$$\mathbf{x}_T = \mathbf{x}_T(\mathbf{s}, \mathbf{p}_T, c_1, c_2, \mathbf{q}, m) \quad [9]$$
$$a_1 = a_1(\mathbf{s}, \mathbf{p}_T, c_1, c_2, \mathbf{q}, m)$$
$$a_2 = a_2(\mathbf{s}, \mathbf{p}_T, c_1, c_2, \mathbf{q}, m)$$

Second, an expenditure function is used to describe the analytic Bradford bid curve used in contingent valuation. The expenditure function is the mathematical inverse, $v^{-1}(\bullet)$, of the utility function, equation [8], taken about u,

$$e = e(\mathbf{s}, \mathbf{p}_T, c_1, c_2, \mathbf{q}, u) \quad [10]$$

The expenditure function states the minimum income required to maintain a level of satisfaction u at prices and service levels $(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q})$.

Conventional Procedures for Valuing On-Site Visits and Activities

It has become common practice to approach recreation benefits in one of two ways. The first approach focuses on the value of particular local activities. The second approach values the entire trip, but attributes this value to a primary activity. Both approaches ignore the substitutions and bundlings that individuals make across the wide range of possible activities. Therefore, neither approach accurately captures the value of visits and activities within a complex setting.

The local activity approach values individual activities from origins within the Tongass. This approach values each activity as if an individual were engaged in a local single-purpose trip, and tends to ignore any substitutions or complementarities between activities. Implemented using a demand-based valuation method, this local activity approach results in a Marshallian independent activity valuation for the ith activity, $MIAV_i$. This $MIAV_i$ is,

$$MIAV_i = \int_{\bar{c}_i}^{c_i^*} a_i(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)dc_i \qquad [11]$$

the $\bar{c}_i$ is the current cost of activity i and c_i^* is a cost high enough to eliminate all participation in this activity. A total Marshallian activity valuation, MIAV, would be obtained by summing up across all $MIAV_i$'s,

$$MIAV = \int_{\bar{c}_1}^{c_1^*} a_1(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)dc_1 \qquad [12.1]$$

$$+ \int_{\bar{c}_2}^{c_2^*} a_2(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)dc_2 \qquad [12.2]$$

The second approach values the entire Tongass experience but attributes this overall valuation to the primary activity purpose of the trip. For instance, if hunting were the primary purpose, the entire valuation would be attributed to hunting. This approach first estimates an approximation to the true demands for travel services, $x_T(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)$. This approximation measures demand for trips that have a specific primary purpose. Trip demand is a function of a travel cost index, $\mathbf{p}_T$. Given an estimate of $x_T(\bullet)$, this primary purpose activity valuation is,

$$PAV = \int_{\bar{p}_T}^{p_T^*} x_T(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)d\mathbf{p}_T \qquad [13]$$

where $\bar{p}_T$ is the current travel cost index and p_T^* is a cost high enough to eliminate all trips to the Tongass.

A Valid Valuation Framework for Visitor Values

A valid valuation of a visit to the Tongass measures the money value of the increment in well-being obtained from the visit. The utility functions given in equations [6] and [8] quantify this change in well-being and allow us to translate it into money terms. The initial level of economic well-being, u^0, is given by equation [8]. The total visitor use value, TVUV, of a visit to the Tongass is the maximum amount of money an individual would be willing to pay for the trip while remaining no worse off than u^0. This TVUV is,

$$u^0 = v(\mathbf{s},\bar{\mathbf{p}}_T,\bar{\mathbf{c}}_1,\bar{\mathbf{c}}_2,\mathbf{q},m^* - TVUV) \qquad [14]$$

TVUV measures the maximum amount an individual would pay for a Tongass trip if the overall trip bundle were available on a market.

An explicit definition of TVUV can be written in terms of the expenditure function:

$$TVUV = e(\mathbf{s},\mathbf{p}_T^*,c_1^*,c_2^*,\mathbf{q},u^0) - e(\mathbf{s},\bar{\mathbf{p}}_T,\bar{\mathbf{c}}_1,\bar{\mathbf{c}}_2,\mathbf{q},u^0) \qquad [15]$$
$$= m^* - e(\mathbf{s},\bar{\mathbf{p}}_T,\bar{c}_1,\bar{c}_2,\mathbf{q},u^0)$$

By equation [15], the value of the total Tongass visit is the difference between an individual income, m^*, and the minimum amount of income needed to attain u^0. Equation [15] is the analytical form of the Bradford bid curve that provides the basis of contingent valuation (Randall et al. 1974). Contingent valuation may be used to elicit the valid TVUV directly from visitors to the Tongass.

The TVUV may be measured exactly if a set of compensated demands for market goods can be estimated. In practice, the Marshallian demands (equation [9]) are typically substituted for the compensated demands. Using the Marshallian demands for travel services to the Tongass,

$$TVUV \approx \int_{\bar{p}_T}^{p_T^*} x_T(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)d\mathbf{p}_T \qquad [16]$$

Equation [16] gives an approximate total visitor use value where the accuracy of the valuation depends on how close the Marshallian demands approximate the compensated demands.

Notably, the right hand side of equation [16] should be close in size to the primary activity valuation, PAV, of equation [13]. If x_T is an accurate index of $\mathbf{x}_T$, PAV should approximate the right-hand side of [16], implying that,

$$PAV \approx TVUV \qquad [17]$$

The PAV may, therefore, provide a good approximation to the value of the total Tongass trip experience for those who participate in a particular primary activity. If it is interpreted as an "activity value," however, it is likely to overstate the valuation of that one activity. With the PAV, all the economic value of the trip is allocated to one specific activity, a procedure that we believe is invalid for many, if not most, Tongass trips. PAV would result in biased management if used in allocating forest resources to specific activities.

Effective management of forest resources requires a valid framework for valuing both the site visit experience to the Tongass and specific activities. To meet this management objective, it is necessary to disaggregate TVUV into portions that are attributable to the overall site experience and to specific activities.

It is a general result that TVUV is not equal to the sum of the site experience value and the activity values estimated independently (Hoehn and Randall 1989). Rather, a valid TVUV can be estimated by valuing the visit in all its dimensions holistically, or sequentially by introducing incremental components of the visit in some sequence. The Hoehn-Randall result imposes converse restrictions on a valid procedure for disaggregating TVUV into its component values. Perhaps, a simultaneous disaggregation procedure can be found. Currently, a more practicable procedure is to value the elements of a visit sequentially by incrementally adding additional alternatives to the Tongass trip package.

Conceptually, this sequential valuation is obtained by incrementally reducing prices from $\mathbf{p}_T^*$, c_1^*, and c_2^*, where no visits are made, to their current levels, $\bar{\mathbf{p}}_T$, $\bar{c}_1$, and $\bar{c}_2$. One such sequence of valuation begins with prices at $(\mathbf{p}_T^*, c_1^*, c_2^*)$ and reduces $\mathbf{p}_T^*$ to $\bar{\mathbf{p}}_T$ first, c_1^* to $\bar{c}_1$ second, and c_2^* to $\bar{c}_2$ third. This sequence results in,

$$\text{TVUV} = m^* - e(\mathbf{s},\bar{\mathbf{p}}_T,\bar{c}_1,\bar{c}_2,\mathbf{q},u^0) \quad [18.1]$$

$$= m^* - e(\mathbf{s},\bar{\mathbf{p}}_T,c_1^*,c_2^*,\mathbf{q},u^0) \quad [18.2]$$

$$+ e(\mathbf{s},\bar{\mathbf{p}}_T,c_1^*,c_2^*,\mathbf{q},u^0) - e(\mathbf{s},\bar{\mathbf{p}}_T,\bar{c}_1,c_2^*,\mathbf{q},u^0) \quad [18.3]$$

$$+ e(\mathbf{s},\bar{\mathbf{p}}_T,\bar{c}_1,c_2^*,\mathbf{q},u^0) - e(\mathbf{s},\bar{\mathbf{p}}_T,\bar{c}_1,\bar{c}_2,\mathbf{q},u^0) \quad [18.4]$$

A valid aggregation design yields both site experience and activity-specific valuations. Equation [18.2] values the site visit experience as if no explicit forest-related activities are available. We denote this valuation as a site experience value or SEV. Equation [18.3] values activity 1 as if activity 2 were not available. Equation [18.4] values activity 2 given that activity 1 is available. This sequencing in the availability of activities accounts for the impact of substitution, complementarity, and the budget constraint on the disaggregate valuations.

The disaggregation of TVUV into its component values has three significant features. First, the sum of the sequenced valuations is unique—the sum of equations [18.2] through [18.4] adds up to the total valuation given in equation [18.1]. One can pick any sequence of valuation and the total valuation remains unaffected. Second, the total valuation is in general different from the sum of the component values independently estimated. Third, a valid set of disaggregate values can be obtained by using a sequence of valuation. Any sequence must begin at $\mathbf{p}_T^*$, c_1^*, and c_2^* and end at $\bar{\mathbf{p}}_T$, $\bar{c}_1$, and $\bar{c}_2$. However, the component valuations are not unique, but vary with the selected sequence of valuation. With a different valuation sequence—say, one that shifts c_2^* to $\bar{c}_2$ before shifting c_1^* to $\bar{c}_1$—a different set of activity-specific valuations would be obtained. With this second sequence, activity 2 would be valued as if activity 1 were not available, and activity 1 would be valued given the availability of activity 2.

Equation [18] provides a valuation framework for both contingent valuation and demand based methods such as the travel cost approach. With contingent valuation, equation [18] is simply translated into a set of verbal valuation scenarios. Following [18.2], SEV is elicited assuming that no specific activities were available. Following [18.3], a valuation of activity 1 is elicited assuming that activity 2 is not available. As in [18.3], the value of activity 2 is elicited assuming the possibility of substituting activity 1.

A framework for demand-based methods is obtained by substituting market demands for the expenditure functions in equation [18]. This substitution results in

$$\text{TVUV} \approx \int_{\bar{\mathbf{p}}_T}^{\mathbf{p}_T^*} x_T(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m)d\mathbf{p}_T \quad [19.1]$$

$$= \int_{\bar{\mathbf{p}}_T}^{\mathbf{p}_T^*} x_T(\mathbf{s},\mathbf{p}_T,c_1^*,c_2^*,\mathbf{q},m)d\mathbf{p}_T \quad [19.2]$$

$$+ \int_{\bar{c}_1}^{c_1^*} a_1(\mathbf{s},\bar{\mathbf{p}}_T,c_1,c_2^*,\mathbf{q},m)dc_1 \quad [19.3]$$

$$+ \int_{\bar{c}_2}^{c_2^*} a_2(\mathbf{s},\mathbf{p}_T,\bar{c}_1,c_2,\mathbf{q},m)dc_2 \quad [19.4]$$

The framework allows one to approximate a set of valid valuations using a demand-based approach. Equation [19.2] gives the demand-based estimate of SEV. As in equation [18.2], SEV is evaluated as if the individual could engage in no specific activities. As in the last two lines of equations [18], [19.3], and [19.4] evaluate, respectively, activity 1 assuming that activity 2 is unavailable and activity 2 assuming that activity 1 is available. The extent to which the valuation obtained with [19] approximates those obtained with [18] depends on how closely the Marshallian demands approximate a compensated demand system.

As mentioned above, the independent activity valuations obtained with conventional procedures are not generally consistent with the valid valuation framework. In equations [11] and [12], MIAV_2 is evaluated assuming that individuals can substitute to some other activity. These same conditions hold for the last-in-sequence valuation of activity 2 in [19.4]. This consistency occurs only for the last-in-sequence valuation. The valuation of activity 1, for example, is evaluated as if activity 2 is unavailable, while MIAV_1 assumes the availability of activity 2. Even if MIAV (equation [12]) had been defined to include a value for visiting the Tongass without participating in explicit activities, total MIAV would still deviate from the valid value, TVUV. It is a general result that the total value of a complex array of services is not equal to the sum of the independent valuations of the services (Hoehn and Randall 1989).

One may speculate as to how the valid TVUV might deviate from the sum of the independent valuations. When valuing the existing array of services, substitution relationships among the site experience and the various activities would tend to make TVUV larger than

the sum of independent valuations. Complementary relationships would tend to have the opposite directional effects compared to substitution relationships.

RESIDENTIAL QUALITY OF LIFE

Approximately 65,000 people live in the small cities, towns, and private lands that border the Tongass National Forest. Since the Tongass National Forest dominates the geography and environment of southeast Alaska, it is an integral component of day-to-day living. Tongass scenes and vistas are a backdrop for work and leisure activities, while its biological resources provide recreational opportunities, food, and fuel. Management decisions on the Tongass affect most every aspect of life in southeast Alaska.

To develop a framework for valuing residential experiences and activities, we first consider the residential choice process and conventional valuation methods. We then adapt the visitor valuation framework to the problem of estimating residential use values and discuss methods for empirical implementation.

The Residential Choice

The development of a residential valuation framework is similar to that of the visitor valuation model. Instead of the visitor's trip experience, b_T, a resident's well-being depends upon the residential experience. This residential experience, b_R, depends upon (1) local residential services, $\mathbf{h}_R$, such as housing; (2) the list of Tongass activities enjoyed by the resident, **a**; and (3) the unpriced services, **s**, that provide the background experience of residing near the Tongass. Algebraically, the residential experience is a function,

$$b_R = b_R(\mathbf{h}_R, \mathbf{a}, \mathbf{s}) \qquad [20]$$

Replacing $\mathbf{b}_T$ in equation [1] with $\mathbf{b}_R$, the structure of a resident's economic well-being is represented by,

$$u = u(\mathbf{s}, b_R, \mathbf{x}, \mathbf{q}) \qquad [21]$$

The level of economic well-being actually attained by a resident depends on four sets of variables. First, a resident's economic well-being depends on the unpriced services of the Tongass. Second, it depends on the price, $\mathbf{p}_R$, of local residential services, $\mathbf{h}_R$, and the cost of leisure activities, c_i, $i \in \{1,2\}$. Third, it depends upon the price of nonlocal goods, **p**, and nonlocal environmental services, **q**. Finally, a resident's well-being depends on the wages, m_R, obtainable in the local labor market.

Algebraically, the level of well-being attained by a resident is represented by,

$$v(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, m_R) = \max u(\mathbf{s}, b_R, \mathbf{x}, \mathbf{q}) \quad \text{s.t. } m_R \geq c_R(\mathbf{p}_R, c_1, c_2, b_R) + \mathbf{px} \qquad [22]$$

where $c_R(\bullet)$ is derived in a manner analogous to equation [5] and is the cost of producing a level of residential services equal to b_R.

If an individual were to move to a location somewhere outside of southeast Alaska, his/her economic well-being would depend upon the residential variables relevant to that location. These variables are the existence values derived from **s**, prices **p**, environmental services, **q**, and the income, m, earned in the local labor market. In this case, the individual's economic well-being would be,

$$u^0 = v(\mathbf{s}, \mathbf{p}, \mathbf{q}, m) = \max u(\mathbf{s}, 0, \mathbf{x}, \mathbf{q}) \quad \text{s.t. } m \geq \mathbf{px} \qquad [23]$$

In general, we expect the level of well-being obtained by Tongass residents, $v(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, m_R)$, to be at least as great as the level of well-being, u^0, that they could obtain by residing elsewhere. If $v(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, m_R)$ were less than u^0, the individual would move to the location where he/she would be better off.[2]

Equations [22] and [23] summarize the optimizing choices open to a Tongass resident. These optimizing choices can be used to define both a residential demand system and a residential expenditure function. Using Roy's identity and equation [22], the system of residential demands is,

$$\begin{aligned} \mathbf{x}_R &= \mathbf{x}_R(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, m_R) \\ a_1 &= a_1(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, m_R) \\ a_2 &= a_2(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, m_R) \end{aligned} \qquad [24]$$

The residential expenditure function is the mathematical inverse, $v^{-1}(\bullet)$, of equation (22) taken about u,

$$e = e(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q}, u). \qquad [25]$$

The expenditure function states the minimum income required to maintain a level of satisfaction u at prices and service levels $(\mathbf{s}, \mathbf{p}_R, c_1, c_2, \mathbf{q})$.

A Conventional Valuation Approach

A resident of southeast Alaska gains two types of use values from the Tongass. The first arises through the general residential experience of having the Tongass as a backdrop for day to day activities. The second comes from using Tongass services in specific activities.

Conventional procedures for estimating residential use values are likely to focus on activity values and ignore the contribution of the Tongass to residential quality of life. In addition, like the conventional activity-specific valuations obtained for visitors (discussed above), the activity-specific approach to resident's values ignores the substitutions and bundlings that individuals make across the range of alternative activities available.

[2]By wage income, we mean real income. Money wage income earned by different individuals in different locales must be adjusted for cost of living differences. We discuss one adjustment procedure in the subsection on hedonic analysis.

The conventional activity approach values the activities of residents in a manner analogous to the approach for visitors. The conventional approach values each activity as if an individual were engaged in a local single-purpose trip. The Marshallian independent-activity valuation for an activity engaged in by residents is analogous to equation [11]. Replacing the visitor's activity demands in equation [11] with those of a resident, the resident's $MIAV_1$ is,

$$MIAV_i = \int_{\bar{c}_i}^{c_i^*} a_i(\mathbf{s},\mathbf{p}_R,c_1,c_2,\mathbf{q},m)dc_i \qquad [26]$$

where $\bar{c}_i$ is the current activity cost and c_i^* is a cost high enough to drive participation to zero.

A total Marshallian activity valuation for residents, MIAV, would be obtained by summing up across all $MIAV_i$'s,

$$MIAV = \int_{\bar{c}_1}^{c_1^*} a_1(\mathbf{s},\mathbf{p}_R,c_1,c_2,\mathbf{q},m_R)dc_1 \qquad [27.1]$$

$$+ \int_{\bar{c}_2}^{c_2^*} a_2(\mathbf{s},\mathbf{p}_R,c_1,c_2,\mathbf{q},m_R)dc_2 \qquad [27.2]$$

Equation [27] has two shortcomings as a total valuation of residential values. First, the valuation ignores the substitution and bundling that goes on across alternative activities. Second, it ignores the contribution of **s** to the general quality of residential life.

A Valid Framework for Residential Use Values

A valuation framework is derived from the optimizing tradeoffs that residents are willing to make between Tongass services and other goods and services they valued. Since equations [22] and [23] summarize these tradeoffs, these two equations are the analytical building blocks for a residential valuation framework.

The total residential use value (TRUV) of Tongass services is the maximum amount of income an individual would give up in order to reside near the Tongass[3]. This TRUV is composed of two components. First, there is the income an individual actually gives up in order to reside near the Tongass. This is the difference between the maximum income an individual could earn in another locale, m, and the income earned in southeast Alaska, m_R. However, this difference in net income, $m - m_R$, may not fully account for the gain in economic well-being an individual enjoys by residing near the Tongass. The second component of TRUV is the additional amount of income an individual would pay (but is not required to pay) in order to live near the Tongass. Since this second component is a pure consumer's surplus, we denote it as residential surplus value, RSV.

Algebraically, the components of residential use value are defined by,

$$u^0 = v(\mathbf{s},\mathbf{p},\mathbf{q},m) = v(\mathbf{s},\mathbf{p}_R,c_1,c_2,\mathbf{q},m_R - RSV) \qquad [28.1]$$

$$= v[\mathbf{s},\mathbf{p}_R,c_1,c_2,\mathbf{q},m - (m-m_R) - RSV] \qquad [28.2]$$

$$= v(\mathbf{s},\mathbf{p}_R,c_1,c_2,\mathbf{q},m - TRUV) \qquad [28.3]$$

The first line of equation [28] defines residential surplus value, RSV, as the maximum amount of income an Alaska resident would give up—from current local income—in order to continue to reside near the Tongass. The second and third lines show that total residential use value is the sum of RSV and the income differential, $m - m_R$.

At this point, note that the standard result of spatial equilibrium theory is that each individual is indifferent between living at his/her current location and living elsewhere, the labor and housing markets extract all residential consumer's surpluses and—in the terms introduced above—RSV is zero and TRUV is equal to the wage differential. This standard result, however, is dependent on two crucial assumptions: first, individuals have identical utility functions and, second, moving costs are zero. If utility functions differed, a minority of Americans with unusual preferences may be able to enjoy a positive RSV in an atypical location, unconcerned that outsiders would try to bid their jobs and housing away from them. If moving costs were substantial, RSV may be positive for some individuals (who prefer their current location and are protected from competition in the job and housing markets by the moving costs that potential competitors would face) and negative for others who would be willing to pay something, but not as much as the moving cost, to move away from their current locations. If utility functions were identical but moving costs were positive, the absolute value of RSV for rational individuals would be bounded by moving costs.

Contingent valuation and hedonic analysis provide two different ways of directly estimating residential use value. Contingent valuation formats may be constructed to measure TRUV and both of its components. Hedonic analysis focuses on the income differential and the adjustment of this differential for differences in the cost of living. Hedonic analysis is discussed in detail later in this section.

Residential use values, TRUVs, may be disaggregated and attributed to the general residential experience and to specific activities. This disaggregation procedure and its implications for valuation design are analogous to the disaggregation procedure used with the TVUV obtained for visitors. As with TVUV in equation [18], TRUV is,

$$TRUV = m^* - e(\mathbf{s},\bar{\mathbf{p}}_R,\bar{c}_1,\bar{c}_2,\mathbf{q},u^0) \qquad [29.1]$$

$$= m^* - e(\mathbf{s},\bar{\mathbf{p}}_R,c_1^*,c_2^*,u^0) \qquad [29.2]$$

$$+ e(\mathbf{s},\bar{\mathbf{p}}_R,c_1^*,c_2^*,u^0) - e(\mathbf{s},\bar{\mathbf{p}}_R,\bar{c}_1,c_2^*,u^0) \qquad [29.3]$$

$$+ e(\mathbf{s},\bar{\mathbf{p}}_R,\bar{c}_1,c_2^*,u^0) - e(\mathbf{s},\bar{\mathbf{p}}_R,\bar{c}_1,\bar{c}_2,u^0) \qquad [29.4]$$

[3]*This assumes frictionless mobility. If the cost of moving one's household to or from southeast Alaska were substantial, as well it might be, there may well be people in southeast Alaska who would prefer to live elsewhere (and vice versa) but are constrained by moving costs.*

The first line of equation [29] defines the overall residential use value. The second line defines the value of the residential experience, REV, when considered in the absence of the availability of specific activities. This REV is the value of the Tongass as it contributes to the background level of residential quality of life.

The third and fourth lines of equation [29] measure residential activity values, RAV_i—the contributions specific activities make to TRUV. The third line values the first activity as if the second activity were unavailable. The fourth line values the second activity given that the first activity is available as a substitute.

Equation [29] outlines a contingent valuation of the residential experience and activities. Each of equations [29.2] through [29.4] describe a different dimension of an analytical Bradford bid curve. Contingent valuation formats may be designed to elicit REV as described by equation [29.2] or RAV_1 and RAV_2 as described by, respectively, equations [29.3] and [29.4].

A complete travel cost valuation of TRUV is not likely to be possible, because the demands for residential services, $\mathbf{h}_R(\bullet)$, do not involve travel costs in any direct manner. However, it should be possible to at least measure activity values using the travel cost approach. Using a travel cost estimate of $a_1(\bullet)$, equation [29.3] is restated as,

$$RAV_1 = e(\mathbf{s},\bar{\mathbf{p}}_R,c_1^*,c_2^*,u^0) - e(\mathbf{s},\bar{\mathbf{p}}_R,\bar{c}_1,c_2^*,u^0) \approx \int_{\bar{c}_1}^{c_1^*} a_1(\mathbf{s},\bar{\mathbf{p}}_R,c_1,c_2^*,\mathbf{q},m_R)dc_1 \quad [30]$$

Similarly, equation [29.4] is restated as,

$$RAV_2 = e(\mathbf{s},\bar{\mathbf{p}}_R,c_1^*,c_2^*,u^0) - e(\mathbf{s},\bar{\mathbf{p}}_R,c_1^*,\bar{c}_2,u^0) \approx \int_{\bar{c}_2}^{c_2^*} a_2(\mathbf{s},\mathbf{p}_T,c_1,c_2,\mathbf{q},m_R)dc_2 \quad [31]$$

OPTION VALUE

Given that relatively unspoiled environments are frequently the target of proposals to change them in some way, it is possible that people may be willing to pay to preserve options for future use of those environments. This basic idea has led to two quite distinct concepts of option value. The first of these, usually called *option value*, addresses the willingness to pay to ensure an option for future use. There is a long and tortuous literature on option value (reviewed by various authors in Peterson and Swanson 1987), and even the question of whether option value is positive seems to have no general answer. There is some agreement that the "fair bet point," FB, represents maximum WTP for future use of an environment with uncertain service flows (Graham 1981). FB is, however, not a certain price but a set of payments each contingent on a particular outcome.

The maximum certain payment for an option for future use is *option price*, OP, which is equal to the sum of the expected value of future use plus option value (where option value may, depending on the conditions, be positive or negative). Freeman argues that option value is typically quite small, so the value of expected future use is a serviceable approximation of option price.

In developing the conceptual framework for estimating the values of nonmarketed services produced by the Tongass National Forest, we have—for two reasons—decided to pay relatively little attention to the option value issue. The first reason has been stated already: we suspect, with Freeman, that option value is typically small. The second is that it would be a fairly simple operation, were it desired, to present all of our theoretical results in terms of option price. By so doing, anyone who cannot accept our conjecture that the option value issue is empirically unimportant could nevertheless adapt our framework rather easily to include it.

The second option value concept, often called *quasi-option value*, hinges on the idea that one can often change things more easily than put them back the way they were. *If* preservation now permits a choice of preservation or development later, whereas development now permits only development later, *and* there is always the chance that new information may emerge eventually that increases the value of preservation, *then* quasi-option value is the value of keeping one's options open by postponing the development decision. Quasi-option value may well be applicable to many of the characteristics of the Tongass that have been little changed by human intrusion. However, quasi-option value is seldom included in empirical valuation efforts, and the literature remains unsettled concerning the desirability of so doing (Fisher and Hanemann 1985, Peterson and Swanson 1987). Were it desired to include quasi-option value in the conceptual framework for the Tongass study, it should be a fairly direct undertaking.

EXISTENCE VALUE AND OFF-SITE USE VALUE

Though direct use is an important element of resource valuation, it is not a necessary element. Many goods and services are valued for the knowledge that they exist. For instance, American citizens may value the existence of the original copy of the U.S. constitution even though they may never personally view it. Wilderness and natural features may be valued in much the same way. As Krutilla (1967, p. 781) notes, there are many people who gain satisfaction from knowledge that wilderness exists "even though they would be appalled by the prospect of being exposed to it." These types of values are denoted existence values.

Existence value is defined as the value of knowing that some environmental service is produced in a desired condition, independent of any possibility of ever using it (Randall and Stoll 1983). Since the travel cost and hedonic price methods depend on weak complementarity and/or implicit price assumptions—which are satisfied only when some form of use is involved—existence value must be estimated via contingent valuation.

If **s** represents the services produced by the Tongass National Forest, the pure existence value, EV, of these services is defined by,

$$u^0 = v(\mathbf{s},\mathbf{p},\mathbf{q},m) = v(o,\mathbf{p},\mathbf{q},m - EV) \quad [32]$$

For a management proposal that would not eliminate the **s** vector entirely, but instead modify it to **s**′, the change in existence value, ΔEV, is defined by,

$$u^0 = v(\mathbf{s},\mathbf{p},\mathbf{q},m) = v(\mathbf{s}',\mathbf{p},\mathbf{q},m - \Delta EV) \quad [33]$$

The southeast Alaskan environment, being unusual and attractive in many respects, enjoys a clientele whose contact is via photographs, film, television accounts, and so forth. According to the Randall-Stoll definitions, the values derived from these contacts are off-site use values, not existence values. Furthermore, there is the prospect, as yet unrealized, that analyses of the markets in photographs, films, and televised accounts may yield demand-based value estimates for these off-site uses.

Nevertheless, the current state-of-the-art suggests the measurement of off-site use values concurrently with existence values in a contingent valuation framework. With apologies to Randall and Stoll (1983), and for entirely pragmatic reasons, our use of the term "existence values," from this point forward, includes existence and off-site user values.

TOTAL VALUES

The total value of nonmarketed environmental services produced by the Tongass National Forest is composed of use values, option values, quasi-option values, and existence values. Consistent with our discussion of option values (above), we focus on use values and existence values. The total population (of the United States or, perhaps, the world) can be classified into three groups:

1. Tongass residents, who may have residential use values and existence values;
2. Nonresident visitors, who may have visitor use values and existence values; and
3. Nonresident nonvisitors, who may have only existence values. Since these three groups are mutually exclusive, the total value of Tongass services is found by summing the values for the three groups. Existence value for nonresident nonvisitors is defined in equation [32].

For the two user groups, user values and existence values must be aggregated. Again, a valid aggregation requires imposition of a sequence of valuation. While sequence is always arbitrary, we suggest that the following sequence has some intuitive appeal: existence value, site experience (or residential experience) value, use value for activity 1, etc.

For residents, total residential value, TRV, is defined:

$$\begin{aligned}
TRV &= e(o,\mathbf{p}_\mathbf{R}^*,c_1^*,c_2^*,\mathbf{q},u^o) - e(\mathbf{s},\bar{\mathbf{p}}_\mathbf{R},\bar{c}_1,\bar{c}_2,\mathbf{q},u^o) && [34.1]\\
&= e(o,\mathbf{p}_\mathbf{R}^*,c_1^*,c_2^*,\mathbf{q},u^o) - e(\mathbf{s},\mathbf{p}_\mathbf{R}^*,c_1^*,c_2^*,\mathbf{q},u^o) && [34.2]\\
&+ e(\mathbf{s},\mathbf{p}_\mathbf{R}^*,c_1^*,c_2^*,\mathbf{q},u^o) - e(\mathbf{s},\bar{\mathbf{p}}_\mathbf{R},c_1^*,c_2^*,\mathbf{q},u^o) && [34.3]\\
&+ e(\mathbf{s},\bar{\mathbf{p}}_\mathbf{R},c_1^*,c_2^*,\mathbf{q},u^o) - e(\mathbf{s},\bar{\mathbf{p}}_\mathbf{R},\bar{c}_1,c_2^*,\mathbf{q},u^o) && [34.4]\\
&+ e(\mathbf{s},\bar{\mathbf{p}}_\mathbf{R},\bar{c}_1,c_2^*,\mathbf{q},u^o) - e(\mathbf{s},\bar{\mathbf{p}}_\mathbf{R},\bar{c}_1,\bar{c}_2,\mathbf{q},u^o) && [34.5]
\end{aligned}$$

Equation [34.1] defines TRV. Subsequent lines define valid values for its components, given the valuation sequence chosen. Equation [34.2] defines existence value for residents; [34.3] defines residential experience value; and [34.4] and [34.5] define residential activities 1 and 2, respectively.

For visitors, total visitor values (TVV) are defined similarly, as the aggregate sequenced valuation of visitor existence values, site experience values, and visitor activity values.

TOTAL VALUE OF INCREMENTS AND DECREMENTS IN TONGASS SERVICES

The pragmatic purpose of valuation is seldom to value a holistic environmental asset such as the Tongass National Forest on an all-or-nothing basis. Typically, the purpose is to evaluate a proposal to change management practices so as to modify the service vector from **s** to **s**′. The valuation design calls for valuation of the **s** vector, as described above, valuation of the **s**′ vector similarly, and subtraction to calculate the net value of the change from **s** to **s**′.

Under certain conditions, it is possible to value the increment or decrement in services (**s**′ – **s**) directly. Also, it may be possible to value directly the increments or decrements in specific services ($s_i' - s_i$). Aggregation of these increment and decrement values requires a sequenced evaluation design analogous to those developed above. Such a design is specified in Hoehn and Randall.

IMPORTANT FEATURES OF A VALID EVALUATION DESIGN

We conclude this section by drawing attention to some of the significant features of the valid evaluation design (VED).

1. The VED is entirely consistent with the standard model of benefit cost analysis as a test for potential Pareto-improvements. Note that all value definitions are referenced to the initial utility level, u^o. Demand-based approximations, however, lack this attribute (which is why they are, at best, approximations).
2. The VED provides a systematic procedure for defining correctly the various components of total value and aggregating them. This procedure has several important characteristics.
   a. It incorporates use and existence values, and could be extended readily to option and quasi-option values if that were desired.
   b. It addresses the multi-purpose, multi-day, multi-destination trip that is typical of Tongass nonresident visitation by defining site experience values and a set of activity values, and showing how to aggregate them correctly.
   c. A similar procedure addresses the dominance of the Tongass in the southeast Alaskan residential environment.

d. These procedures address the interrelationships among elements of the vector of environmental services, which may be complements or substitutes.

3. The VED satisfies the logical requirement that total value should equal the aggregate of the component values. To accomplish this, it imposes a requirement that the components of total value be valued in some explicit sequence. Further, component values are dependent on the sequence of valuation. For valuing the status quo, or a complex package of changes proposed for simultaneous implementation, any valuation sequence is likely to be arbitrary. In the next section, we discuss a method of approximating the VED via component values without imposing an arbitrary valuation sequence.

APPROACHES TO VALUATION RESEARCH

In this section, we outline briefly some viable approaches to valuation of the recreational, visual, habitat, and quality of life benefits of the Tongass National Forest. The purpose is to suggest a program of research to generate valid estimates of total value and component values.

We consider, first, research strategies that start with total value, then strategies that start with total use value for residents and visitors, and finally, strategies that start with component values.

First, a caveat. This report is not intended to be a treatise on nonmarket valuation methods. While we do offer some specific comments on adapting standard valuation techniques for use within the VED, for the most part we simply assume that, where a method is used, it is used correctly. For example, where we indicate below that the travel cost method (TCM) is, in general, suitable for estimating a particular value component, we are not necessarily endorsing any specific TCM estimate of the value of that component. The issue as to whether a particular estimation exercise is conceptually valid and technically competent, and whether its results are accurate, remains.

Starting with Total Value

Estimating Total Value Directly

Total value can be estimated via contingent valuation (CVM). One needs simply to construct CVM scenarios that correctly capture the notion of total value. Demand-based methods (TCM and hedonic price analysis) are not adaptable to directly estimating total value because they cannot estimate existence values.

From Total Value to Component Values

It is feasible to design CVM formats to generate component valuations consistently with the VED. For total residential value, TRV, for example, one could construct a sequence of CVM questions consistent with equation set [34].

We recommend that a program of CVM research be undertaken to estimate the total value of nonmarket environmental services produced by the Tongass National Forest, using a research design consistent with the VED. Total value and component values should be estimated for the baseline conditions and several alternative management plans. It should be feasible to develop econometric methods for generalizing the resulting value data to evaluate a wide variety of management plans that are, essentially, permutations and combinations of the same elements included in the management plans evaluated directly.

Total Residential Use Value and Total Visitor Use Value

Direct approaches to total value are confined to CVM, since total value includes existence value. However, total residential use value, TRUV (equation [29]), and total visitor use value, TVUV (equation [18]), are themselves holistic concepts that are defined so as to address directly the complex relationships among the services the Tongass provides for residents and visitors. It is, therefore, worthwhile to explore the possibilities of estimating TRUV and TVUV via both CVM and demand-based methods. Its flexibility ensures that, with care, CVM can be used for these purposes. The more interesting questions concern the possibilities for using hedonic price analysis to estimate TRUV and the travel cost method (TCM) to estimate TVUV.

Hedonic Price Analysis to Estimate TRUV

The hedonic approach estimates the value of local environmental goods by measuring the income and price differences that arise across different locations. The basic idea is simple. Locations differ by their environmental endowment; some places offer more amenities than others. If individuals are to locate in both high- and low-amenity areas, something must adjust to make individuals in different locales equally well off.

Economists argue that this adjustment between different locales takes the form of wage income and price differences. Individuals pay to live in high-amenity areas by accepting lower wages and paying higher housing costs. Individuals are compensated for living in low amenity areas by higher wages and lower housing costs.

People move to take advantage of uncompensated differences in quality of life. As an economy approaches a spatial equilibrium, most individuals find no particular advantage in moving. Differences in wage income or housing costs are just enough to compensate for differences in amenities.

Implementation of the hedonic valuation approach rests upon several restrictive assumptions.[4] Nevertheless, hedonic results have proven to be useful in corroborating the value results of other techniques (see Brookshire et al. 1982).

[4] *Among these are the assumptions that people have identical utility functions and that moving is costless.*

Hoehn et al. (1987) and Blomquist et al. (1988) suggest a procedure for implementing the hedonic approach at an interregional level. To show how this procedure might apply to the Tongass case, summarize local residential services as a single good called housing, h_R, and let p_R represent the rental price of housing. The local wage is denoted by m_R. The Hoehn et al. (1987) analysis implies that p_R and m_R would adjust to compensate residents for access to **s**. At a spatial equilibrium, residents are fully compensated for **s** so that

$$u^o = v(\mathbf{s}, p_R, c_1, c_2, \mathbf{q}, m_R) \qquad [35]$$

Full compensation implies that differences in wages, m_R, and differences in the cost of living, p_R, fully account for the value of local amenities.

The Hoehn et al. (1987) analysis shows that the price that individuals give up, p_k, to get a small improvement in the kth amenity, s_k, is,

$$p_k = dm/ds_k - h_R dp/ds_k \qquad [36]$$

where dm/ds_k is an amenity induced wage differential, h_R is the amount of housing the individual purchases or rents, and dp/ds_k is an amenity-induced housing rent differential. Stated less formally, p_k is the implicit market price of an amenity s_k. This market price is the sum of two quantities; dm/ds_k is the amount an individual gives up in the form of lower wages and $h_R dp/ds_k$ is an adjustment for local cost of housing. Hoehn et al. estimate dm/ds_k and $h_R dp/ds_k$ using national, cross-sectional data on wages, rents, and local environmental characteristics.

Blomquist et al. (1988) show that p_k may be used to construct an index of residential quality of life. This index measures the amount of real income residents give up in order to live in a particular locale. For the Tongass, this index would be,

$$I_R = \sum_{k=1}^{K} - p_k s_k \qquad [37]$$

If it were possible to estimate the relevant amenity prices, p_k, for the Tongass, the index I_R gives an estimate of TRUV. In addition, given an initial management plan that yields $\mathbf{s}^0$ and a challenger management plan $\mathbf{s}^1$, one could compute I_R for each plan. The difference between the value of I_R for the initial plan and the value of I_R for the challenger plan would be the residential benefit or damage imposed by the change in plans.

Empirical implementation of this approach for the Tongass would require a major effort. To capture the special environmental features that make the southeast Alaska case so interesting will require more detailed environmental data for southeast Alaska and for alternative sites, and a more elaborate model specification than has yet been attempted. Nevertheless, we recommend that such a study be attempted, with a longer-term perspective. For the short term, it may be useful to attempt to compute rough estimates of I_R using the existing studies of Hoehn et al. (1987) and Blomquist et al. (1988). Since the empirical results of these two studies account for only a few key features of the natural environment, these estimates would miss many special features of the Tongass. Nevertheless, they may provide a reference point for the results obtained through contingent valuation and the travel cost approach.

TCM Approaches to Total Visitor Use Value

Primary activity value (PAV), measured by TCM, is under some conditions an acceptable approximation of TVUV (equation [17]). For certain kinds of trips—including, perhaps, hunting and fishing—the assumptions of TCM (for instance, that the trip is single-destination) are likely to be satisfied. We recommend that several such TCM studies be undertaken and their results interpreted as we suggest (circa equation [17]).

For cruise-ship passengers, a large group of visitors with presumably high values, a TCM approach may be applicable. Nevertheless, it must be viewed as an exploratory effort and its results cross-checked with, for example, a CVM counterpart. A number of conceptual and empirical problems would need to be addressed. Not the least of these is that some cruise-ship passengers appear to be engaged in trips that are multi-purpose even in the large. On a recent trip to Juneau, for example, we encountered cruise-ship passengers from Germany and Japan who presumably included the Alaska cruise as a part of a bigger, multi-destination trip. We recommend an exploratory effort at TCM for cruise-ship passengers.

It may be possible to estimate the full system of market demands for site experience and activity values (equations [9] and [19]). We consider this a challenging conceptual and empirical undertaking. It may require techniques such as hedonic travel cost and discrete choice analysis. This kind of effort would be at or beyond the current theoretical frontier and may require more extensive data sets than are currently available. We recommend that such an effort be considered as part of a long-term valuation strategy.

Starting with Component Values

Estimating Component Values

The components of total value include existence value, site experience values, and activity values. We offer some comments on estimating each.

Existence Value

Contingent valuation offers a flexible method for obtaining existence values from residents, nonresident visitors, or nonresidents who have no intention of ever visiting the Tongass. The key to obtaining accurate and meaningful existence values is a clear understanding of the valuation context.

Four features of the valuation context are crucial for correct estimation and interpretation of existence values. First, the object of valuation is the existence, not current

use or the possibility, however small, of future use. This valuation objective must be clearly conveyed to the respondent.

Second, existence values may be obtained from residents, visitors, and those who never intend a visit to the Tongass. However, if existence values are elicited from residents and visitors in addition to use values, a valid sequence of valuation must be applied. One sequence of valuation would elicit existence values first and then open up the availability of the Tongass sequentially to obtain the site experience values (SEV's or REV's) and the activity values (AV_is).

Third, existence values vary with a respondent's knowledge of the availability of non-Tongass services, $\mathbf{q}$. For instance, the existence value of species in the Tongass may vary with the scarcity or abundance of this species in other locales. Given their potential sensitivity to the level of $\mathbf{q}$, erroneous or irrelevant existence values may be obtained if (1) the contingent valuation format misstates $\mathbf{q}$ or (2) the respondent's knowledge of $\mathbf{q}$ is mistaken.

Fourth, our Valid Evaluation Design recognizes that valuations of particular service values obtained independently of the value of other related services are likely to be misleading. An analogous problem applies to existence values. There is a broad menu of environments that are exposed to the forces of change. Southeast Alaska is but one of these. The logic of the VED implies that the existence value of the Tongass, valued as though its preservation were the proximate policy proposal, would be larger than the EV of the Tongass valued toward the end of a long sequence of preservation policy proposals. We suggest that CVM formats to estimate the existence value of the Tongass environment be designed to emphasize to respondents that the Tongass is one among many possible preservation targets.

Residential Use Values

Total residential use value, TRUV, is composed of residential site experience values and activity values. As indicated above, there is the potential for estimating TRUV with a multi-market, wage-rent hedonic analysis. In general, given a hedonic estimate of TRUV, there is no obvious method of decomposing it to identify REV and the various activity values. A special case may permit valid decomposition: if variables clearly identifiable as capturing REV and access to activities are included in the estimated hedonic equation itself, their parameter estimates may permit such a decomposition.

Visitor Use Values

There are several possibilities for using TCM, in some cases in combination with CVM, to estimate visitor use values. Some examples are suggested below.

1. PAV ($\approx$ TVUV, under certain conditions) may be estimated via TCM, while SEV is estimated with CVM. The residual may be interpreted as the activity value for the primary activity.
2. If this procedure were applied to several primary activities, one could estimate the activity values for each.
3. TCM could be used to estimate $MIAV_i$'s (equations [11] and [12]) for a variety of activities, for both residents and visitors.

RECOMMENDED RESEARCH EFFORTS

To implement this conceptual framework for short-term and longer-term planning, we recommend a series of empirical benefits research projects. These projects are grouped into six categories: (1) total value, contingent valuation; (2) cruiseship passengers, contingent valuation and travel cost; (3) trip-packaging studies; (4) residential use value, hedonic; (5) development of approximation methods for systematic policy evaluation; and (6) activity values, travel cost and contingent valuation.

Total value, contingent valuation.—The valid evaluation design may be directly implemented to estimate total value and component values, using the contingent valuation method. Since pure existence values are expected to be an important component of Tongass benefits, and contingent valuation remains the only feasible method for estimating existence values, it is not possible to estimate total value directly with alternative techniques such as the travel cost method or hedonic price analysis.

Contingent valuation studies can be designed for use with all three mutually exclusive populations: residents, visitors, and nonresident nonvisitors. Holistic and sequential measures of total benefits can be obtained, and the sequential measures provide sequenced estimates of the components of total value. For residents and visitors, the conceptual framework (see equation [34]) suggests a feasible structure for sequential valuation. Holistic and sequential value measures will together provide the basic data for use with the approximation methods (introduced above) that may permit evaluation of many alternative management plans using original value data for a sample of such plans.

The proposed contingent valuation exercise is very promising, but will require a significant investment in questionnaire design and pretesting, data collection, and analysis. Mail and telephone data collection should be used to the extent possible, to minimize the need for face-to-face interviews.

With an immediate start, initial results may be available for the short-term planning effort. The full benefits of this research will accrue in the longer-term planning effort.

Cruiseship passengers, contingent valuation and travel cost.—Cruiseship passengers are a large and growing group of visitors who pay relatively high prices and presumably enjoy large benefits. They enjoy a Tongass site experience by traveling several hundred miles up the inner navigation passage. Scenery and habitat are major attributes of the inner passage, and land management practices on the Tongass National Forest may add to or detract from the benefits of the trip. At various ports in

southeast Alaska, they may choose to participate in specific activities (such as sightseeing flights, boat trips to visit natural and environmental attractions, etc.). The valid evaluation design is well-adapted for evaluating the benefits enjoyed by cruiseship passengers.

A contingent valuation study is recommended to estimate total value holistically and sequentially and component values sequentially. Data could be collected via a mail survey of cruiseship passengers.

Passengers come from a wide variety of international origins, assemble at a few common points of embarkation (frequently Seattle), and disperse through southeast Alaska to some degree as different ships follow different schedules and stop at different ports. This suggests that the travel cost method may be applicable. Some challenges are foreseen: the adaptation of travel cost methods to evaluate multi-origin, multi-destination trips, and the problem of distributing trip values among shipboard facilities and the amenities of the southeast Alaskan environment.

We recommend an exploratory effort at applying the travel cost method as a component of a broader study of cruiseship visits.

There will be complementarities between the total value project and the cruiseship project, especially in design and analysis of the contingent valuation effort. Thus, some substantial cost savings may be obtained by using the same external contractor for both studies.

Trip-packaging studies.—The process by which visitors combine experiences and activities to form a total visit experience is poorly understood. However, we expect it to exhibit important complementarities that have significant implications for forest management.

We recommend that trip-packaging studies—perhaps involving ferry passengers and visitors who use the services of outfitters and guides—be designed and implemented. Contingent valuation seems the most appropriate method, but experimental settings may be an alternative to the more typical survey setting.

Residential use value, hedonic.—The method and the multi-market hedonic model of Hoehn et al. (1987) may be adapted to include the southeastern Alaska environment. The process will require: (1) determining southeast Alaska values for the variables presently in the model; (2) identifying new variables that more completely capture the unique attributes of southeast Alaska, and obtaining their value not only for southeast Alaska but also for every other location in the national model; (3) econometric estimation of the model; and (4) welfare analysis based on the implicit prices of the Tongass-related variables.

We recommend that such an effort be undertaken. If started immediately, some preliminary results may be available for short-term planning, but the full potential of this mark will be realized in the longer term.

Development of approximation methods for systematic policy evaluation.—Approximation methods for systematically evaluating a range of policy or management proposals using value data for a sample of proposals have been suggested. Substantial theoretical and econometric development and empirical testing remains before these methods can be systematically applied.

We recommend that this work be undertaken. Flexible econometric methods have application potential only in the longer term (Hoehn 1989). However, there is a possibility of some preliminary results with simple but restrictive methods in the short term. Cooperative efforts between Forest Service (FS) researchers and external contractors may be appropriate. One approach may be to let a sequence of modest external contracts, calling for conceptual development, econometric efforts, testing, and eventually application. In that way, the potential of this effort can be monitored as work progresses.

Activity values, travel cost and contingent valuation.—Several studies to estimate various activity values have been completed, are underway, or may be initiated and completed in the short term. These studies will provide much of the benefits data for short-term planning. These studies will be undertaken by FS research staff and the staff of cooperating agencies, or because external contracts are already in process.

a. A major study of fishing values in southeast Alaska, funded by the FS and the Alaska Department of Fish and Game, will be initiated soon. It will include travel cost and contingent valuation components, and will produce fishing activity values.
b. Travel cost studies for various recreation activities—lodge use and hunting several big game species—will soon be completed by the FS research staff.
c. The Public Areas Recreation Visitor Survey (PARVS) effort to produce travel cost estimates of recreation activity values may generate some results for southeast Alaska.

These studies have not been designed according to the valid evaluation design recommended here. For the short-term planning effort, it is unlikely that complete empirical results based on the valid evaluation design will be available. For some benefit estimation tasks, these activity values studies will generate the best, or the only, results usable in the short term.

For the longer term, these studies and their successors will produce activity values that—we are optimistic—can be routinely used in valid benefit estimation for policy and management proposals, using the econometric methods developed in project 5 above.

CONCLUSION

This report has discussed the nonmarket benefit evaluation procedures currently used in USDA Forest Service planning, identified the inadequacies of these procedures for estimating the nonmarket benefits of the Tongass National Forest, introduced a conceptual framework for benefits research in Tongass, and suggested a plan of benefit estimation research involving six major projects.

While the Tongass National Forest surely presents a major challenge for nonmarket benefit estimation, many of the situations encountered in other national forests have some of the same characteristics. The conceptual and methodological developments that will flow from this plan of research in the Tongass National Forest

may eventually see widespread application in forest management planning.

LITERATURE CITED

Blomquist, G.C.; Berger, M.C.; Hoehn, J.P. 1988. New estimates of quality of life in urban areas. American Economic Review. 78: 89–107.

Brookshire, D.S.; Thayer, M.A.; Schulze, W.D.; d'Arge, R.C. 1982. Valuing public goods: a comparison of survey and hedonic approaches. American Economic Review. 72: 165–177.

Fisher, A.C.; Hanemann, W.M. 1985. Option values and the extinction of species. Working Paper 269. Berkeley, CA: Giannini Foundation of Agricultural Economics.

Freeman, A.M., III. 1984. The sign and size of option value. Land Economics. 60: 1–13.

Graham, D.A. 1981. Cost benefit analysis under uncertainty. American Economic Review. 71: 715–725.

Hoehn, John P. 1989. Theory and methods for valuing the multi-dimensional impacts of environmental policy. Staff paper No. 89–40, Department of Agricultural Economics, Michigan State Univ., East Lansing.

Hoehn, J.P.; Blomquist, G.C.; Berger, M.C. 1987. A hedonic model of interregional wages, rents, and amenity values. Journal of Regional Science. 27: 605–620.

Hoehn, J.P.; Randall, A. 1989. Too many proposals pass the benefit cost test. American Economic Review. 79: 544–551.

Krutilla, J.V. 1967. Conservation reconsidered. American Economic Review. 57: 777–786.

Peterson, G.; Randall, A. 1984. Valuation of wildlands resource benefits. Boulder, CO: Westview Press.

Peterson, G.; Swanson, C.S. 1987. Toward measurement of total value. Gen. Tech. Rep. RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.

Randall, A.; Ives, B.C.; Eastman, C. 1974. Bidding games for valuation of aesthetic environmental improvements. Journal of Environmental Economics and Management. 1: 132–149.

Randall, A.; Stoll, J.R. 1983. Existence value in a total value framework. In: Rowe, R.D.; Chestnut, L., eds. Managing air quality and scenic resources at national parks and wilderness areas. Boulder, CO: Westview Press: 265–274.

Varian, H.R. 1984. Microeconomic analysis. New York, NY: W.W. Norton & Company, Inc.

Randall, Alan; Hoehn, John P.; Swanson, Cindy Sorg. 1990. Estimating the recreational, visual, habitat, and quality of life benefits of Tongass National Forest. Gen. Tech. Rep. RM-192. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.

A conceptual framework for evaluating the nonmarket benefits of the Tongass National Forest is presented. Standard theory of benefit estimation is expanded to incorporate the array of environmental services in a complex and holistic environment found in the Tongass. As suggested in this report, the general framework outlined can be applied in many national forests. Short- and long-term recreation valuation studies are outlined along with the likelihood of obtaining reliable results from each study.

Keywords: Total valuation framework, contingent valuation method, travel cost method, Alaska recreation

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

Rocky Mountains

Southwest

Great Plains

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect Rd., Fort Collins, CO 80526